IAF SPACE EXPLORATION SYMPOSIUM (A3)
Virtual Presentations - IAF SPACE EXPLORATION SYMPOSIUM (VP)

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RESEARCH ON OBSTACLE AVOIDANCE PATH PLANNING OF SINGLE-ARM SPACE ROBOT USING Q_LEARNING REINFORCEMENT LEARNING APPROACH

Abstract

With the need of increase on on-orbit service ,the most popular form, space robots may encounter fixed or moving obstacles during operation. However, most traditional methods are unable to meet the increasing demand for robustness and intelligent decision-making capabilities of space robots.

Reinforcement learning is an important branch in the field of machine learning. After a large number of interactions with various environments, agents can obtain optimal action strategies under whatever conditions through attemption and learning. In practical applications, the state-action value function table obtained after reinforcement learning can also be used to autonomously adjust execution strategy online, thus making up for the shortcomings of traditional method.

Accordingly, this paper aims to focus on the problem of manipulator's obstacle avoidance planning based on Q_learning reinforcement learning method. And the manipulator of the fixed base space robot works on fixed targets, Firstly, the geometric characteristics of the robotic arm and obstacles are obtained by measurement system, the relative position and attitude model are simplified, and the dynamic analysis of the robotic arm and obstacles are performed. Secondly, the state of the environment and the reward function are designed, and each section of the robotic arm is regarded as a decision-making agent. Subsequently, set up fixed targets and fixed obstacles, and train offline to generate a state-action value function table. Finally, the action according to function table generated by offline training is used as the basis for the motion of manipulator, and applied to the real-time obstacle avoidance path planning of the space environment with moving obstacles to verify the effectiveness of the method.

The simulation results show that based on this method, manipulator on space robot's operating robotic arm can track the fixed space target while achieving effective obstacle avoidance for fixed or moving obstacles. Meanwhile, this method has strong adaptability and decision-making ability in complex dynamic environments.